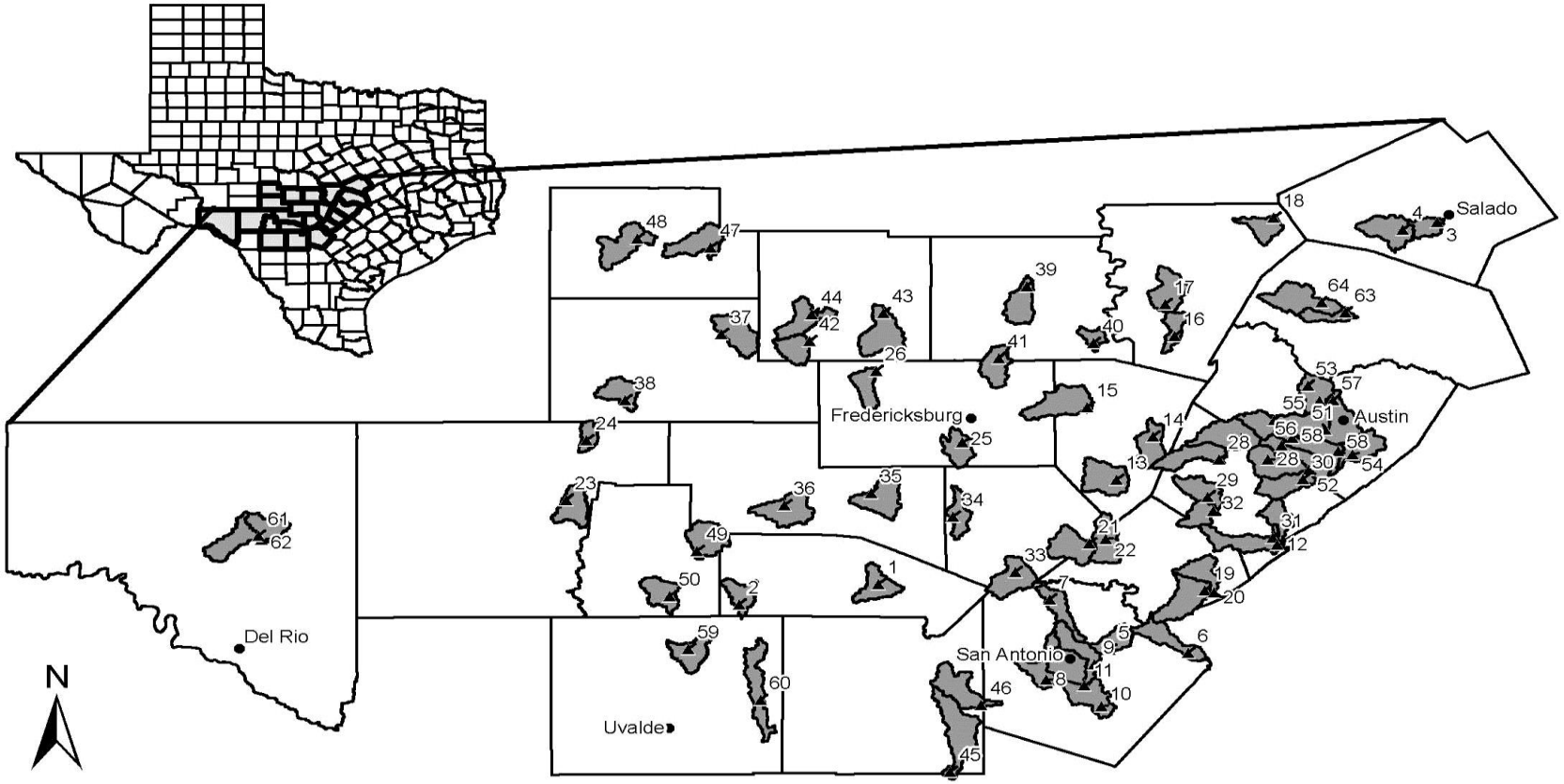
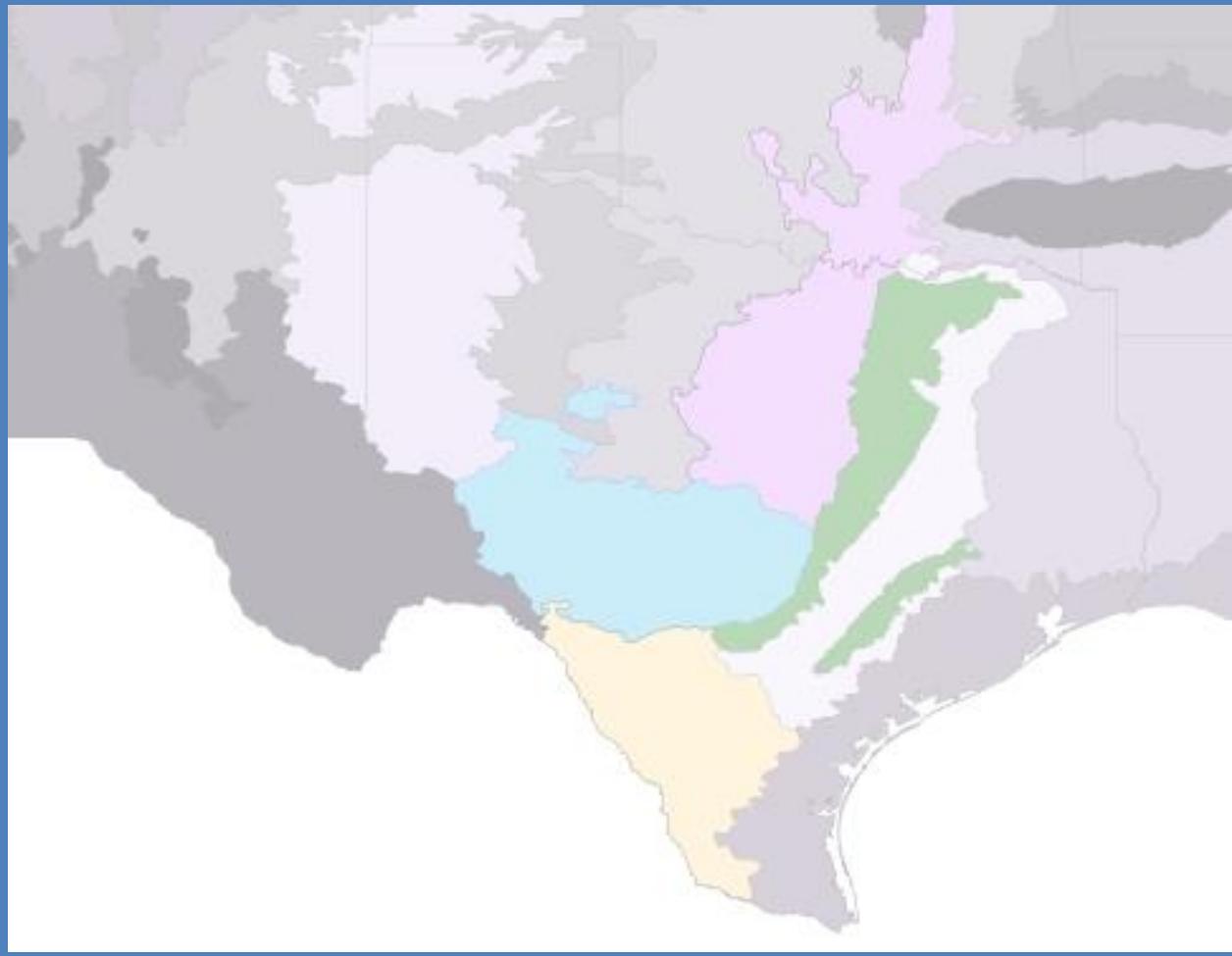
Status of Aquatic Invertebrates in Texas and the Edwards Plateau



Pete Diaz
Texas Fish and Wildlife Conservation Office

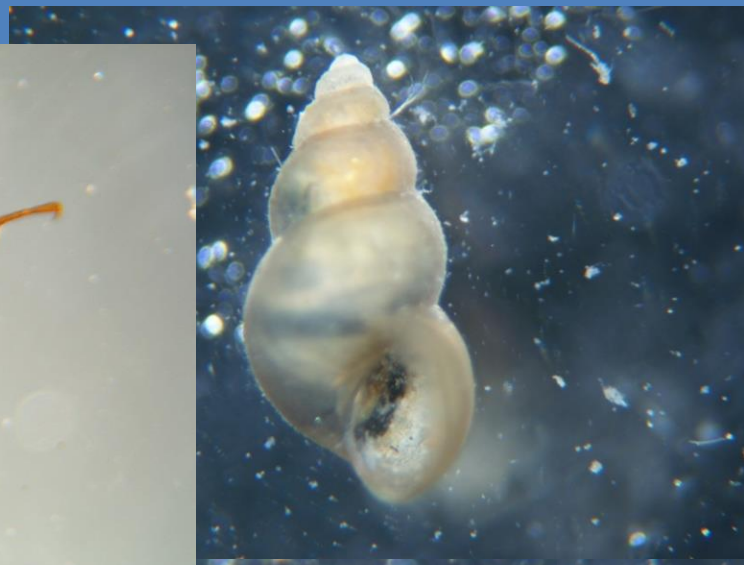
Like a Whole Other Country

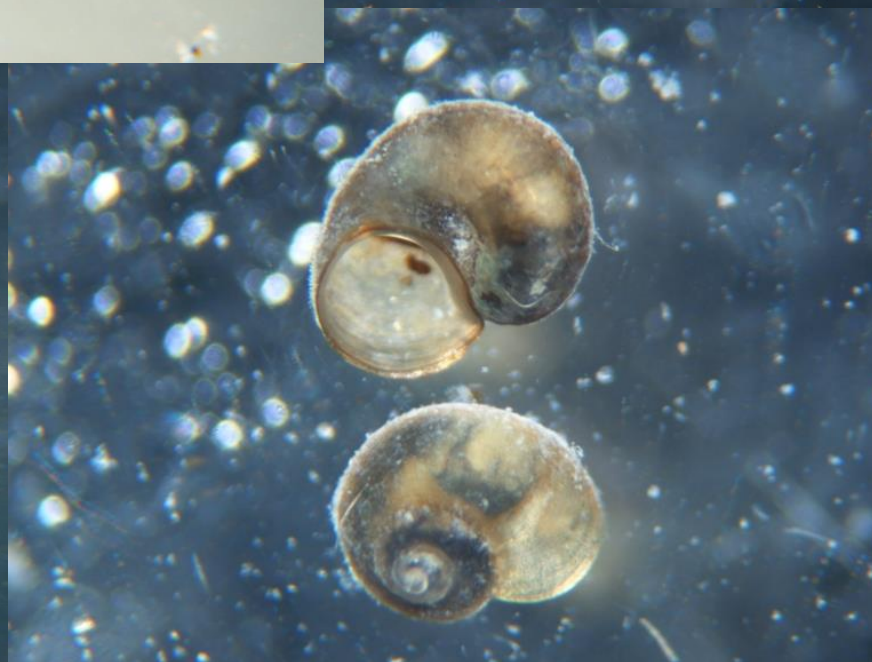
- Wide range in geology
- Precipitation gradient
- Large range in latitudes



Omernick JM 1987

West Texas

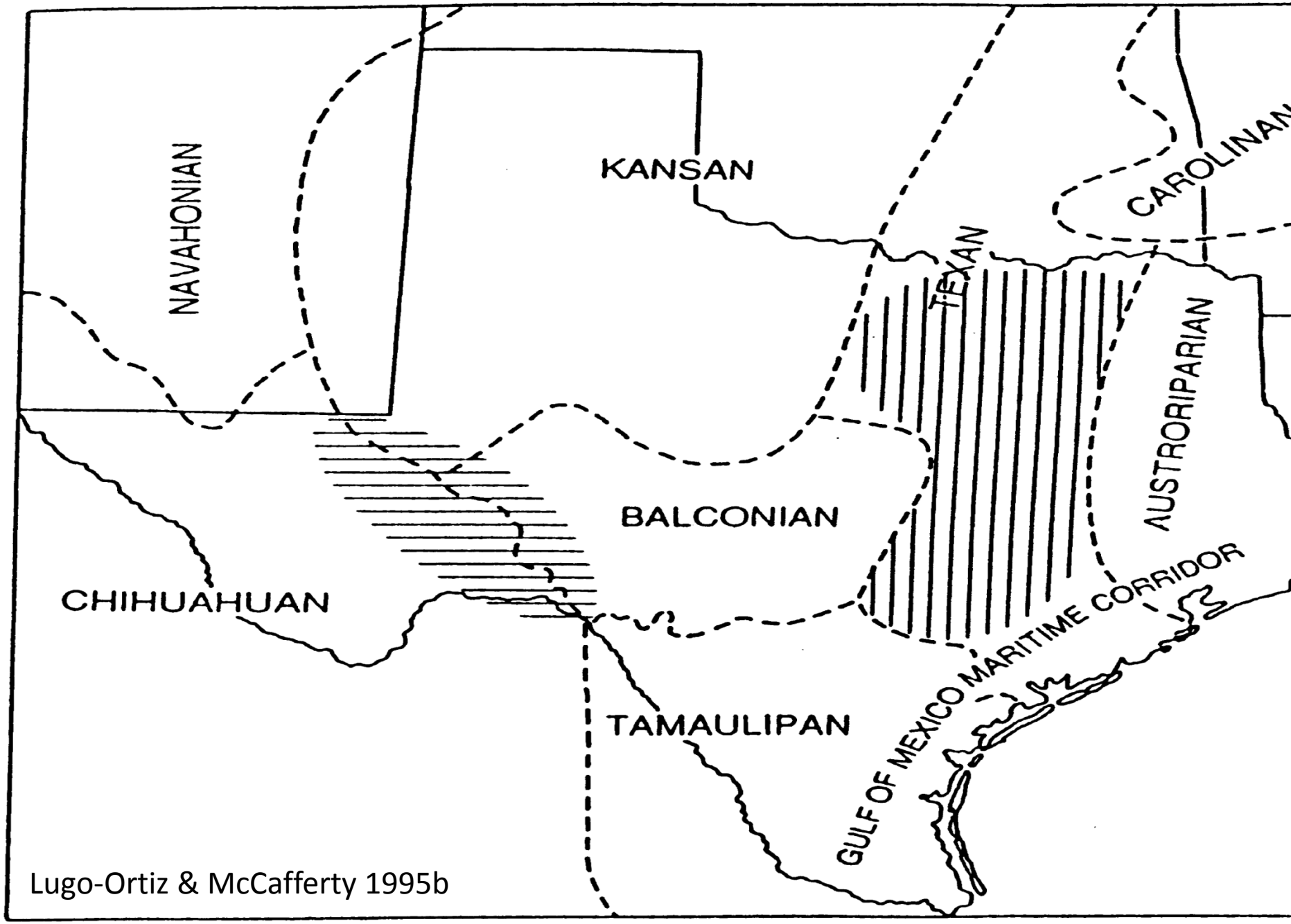




East Texas

- Kleinsasser et al. 2004
- Basic problems with urbanization



Lugo-Ortiz & McCafferty 1995b

Edwards Plateau Phreatic Endemics

Gibson et al. 2008

Edwards Plateau Benthic Endemics

- Threatened due to anthropogenic stressors

Bowles and Arsuffi 1993

Stressors

- Change
  - Large urban growth
  - Large increase in population density
- Result: Large shift in land use over short period of time and increases in municipal water consumption
  - Changes in hydrology, retention time, sediment transport

Urban Stream Syndrome

- Increases the magnitude peak discharges
- Loss of retention time
- Movement of sediment and organic matter
- Channel incision and bank erosion
- Increased turbitity
- Covering of habitat types (e.g. riffles)
- Nonpoint source of urban chemicals

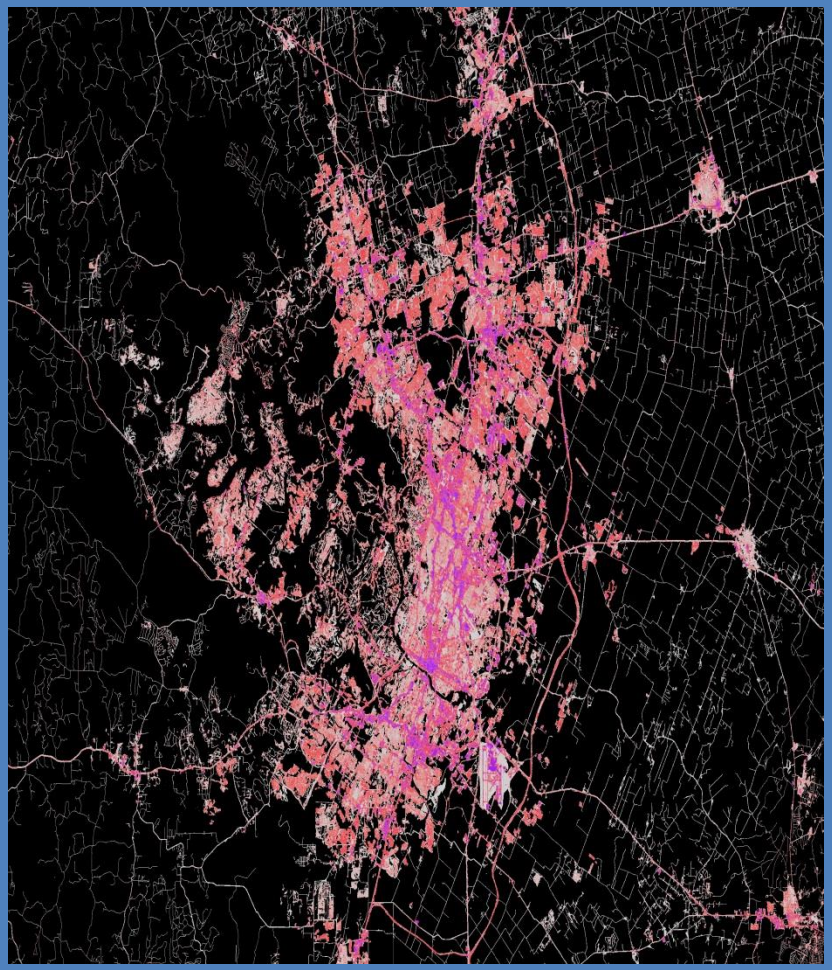
Mayer et al 2005

Urbanization Effects

- Impervious cover used as a surrogate for urbanization
- Acceptable levels <10%
- At 25% detrimental effects on the aquatic community
- However, recent studies suggest lower levels ~1%-5% (King et al. 2011)

Monitoring the Sprawl

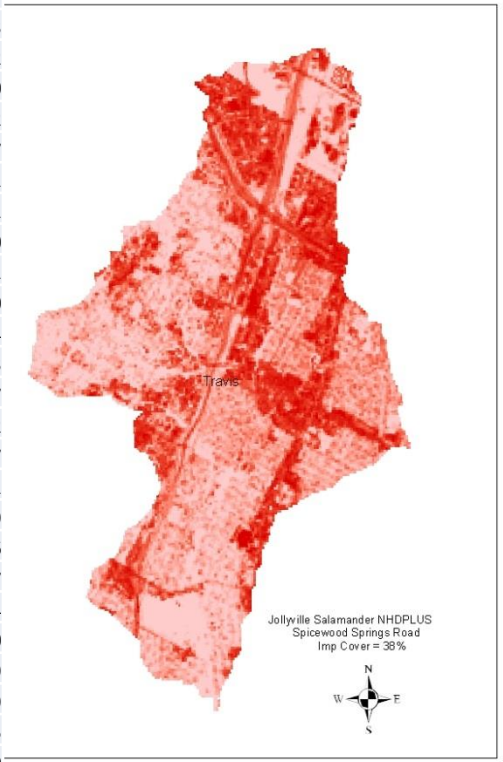
- Two projects within the Edwards
  - *Eurycea* Toxicity Project
    - 21 Springs in Travis, Williamson and Hays Counties
  - Hill Country Urban Intensity Index
    - McMahon and Cuffney 2000
    - ~60 Sites



Methods Euyrcea Tox

- All areas delineated using NHD Plus at the catchment level
- All land cover data taken from the NLCD 2006
- Impervious cover calculated using weighted averages
- Aquatic invertebrates sampled using a surber sampler (N = 3)
- Hydrolab (DO, Temp, Conductivity, pH)
- Passive water quality samplers
- Collection of salamanders and fish for contaminant residue analysis at Columbia Miss, USGS

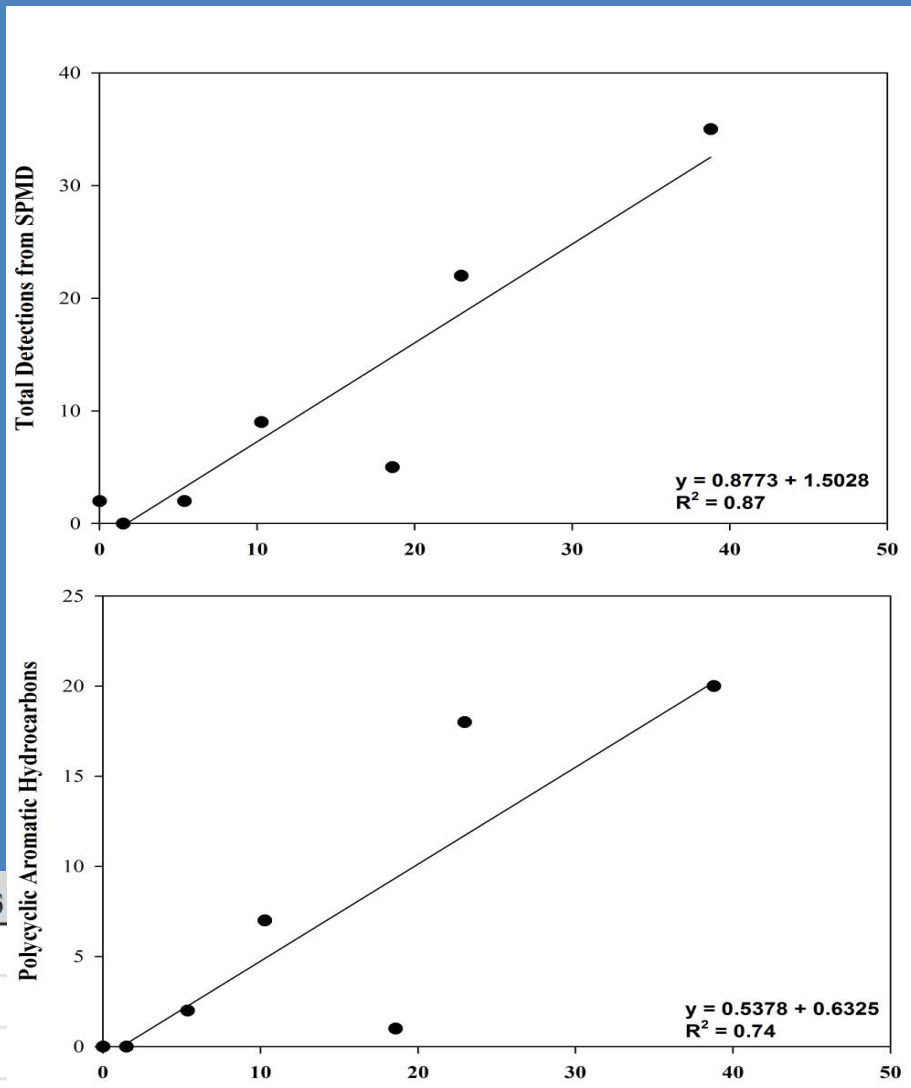
VALUE	COUNT
0	5580
1	1007
2	163
3	112
4	80
5	72
6	67
7	61
8	61
9	50
10	51
11	50
12	54
13	43
14	57
15	32
16	37
17	41
18	49
19	36
20	47
21	54
22	40
23	49
24	59
25	55
26	50
27	46
28	56
29	48



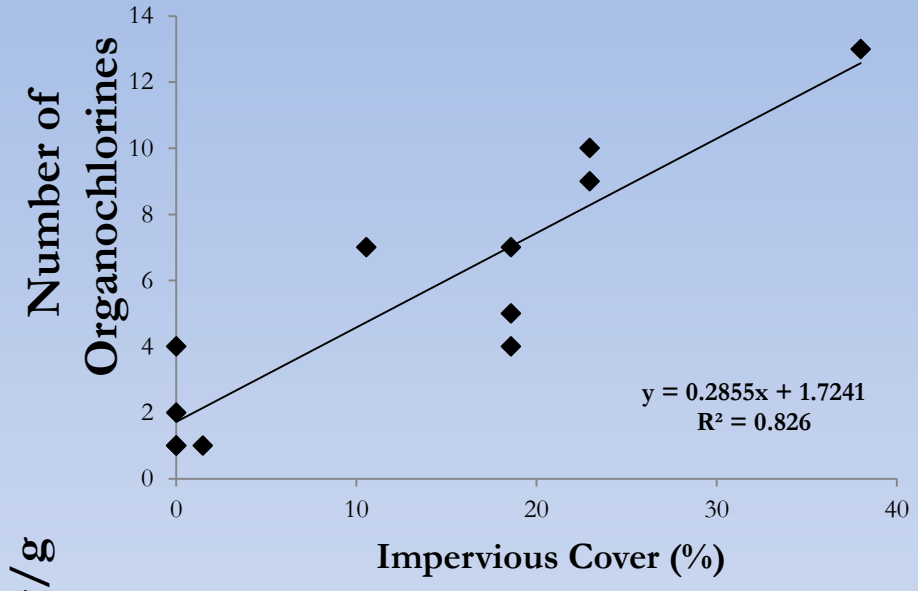
Water Quality from Passive Samplers

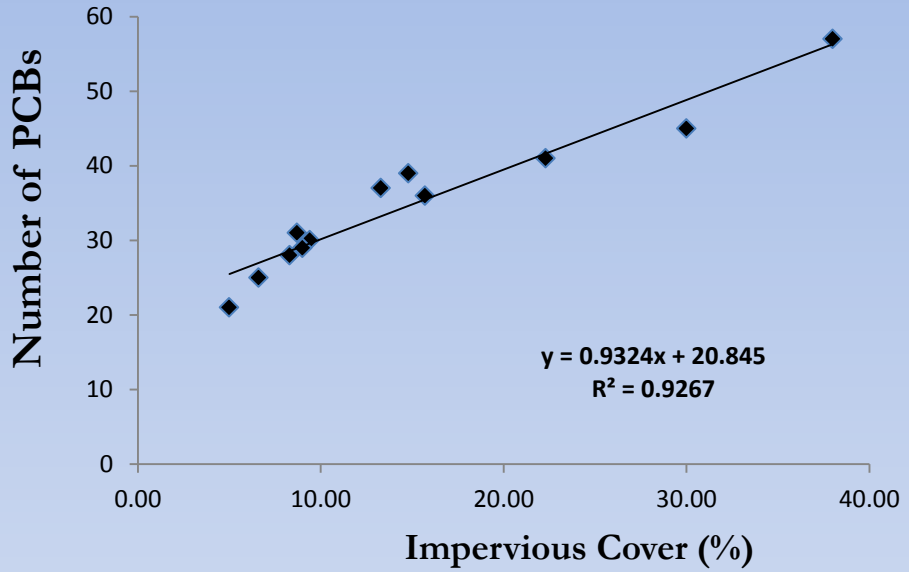
- Seven sites
- Overall the more impervious cover, the more contaminants within the water
  - r = 0.93; t = 5.86; p = 0.002
- PAH driving the relationships

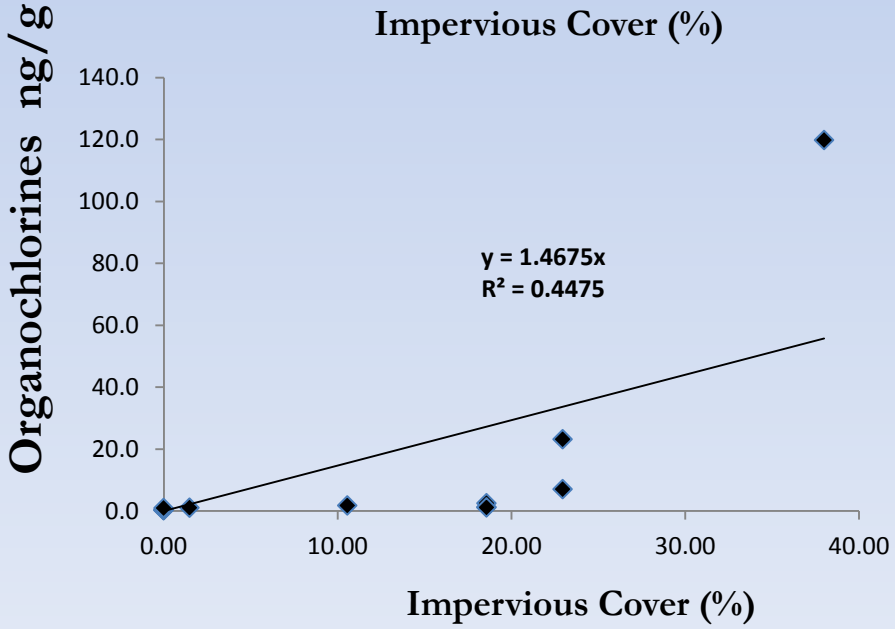
Site Name	% Imperv. Cover	PAHs	ww	estrogen screen	OCs	PCBs	PBDEs
Lanier Spring	0%	0	4	0	2	0	0
Twin Springs Preserve (GS)	2%	0	4	0	0	0	0
Swinbank (GS)	5%	2	6	0	0	0	0
Trib 4	10%	7	6	0	2	0	0
Trib 6 (TR6)	18%	1	6	1	3	0	0
Troll Springs	22%	18	8	1	2	0	1
Spicewood	38%	20	7	0	14	1	0

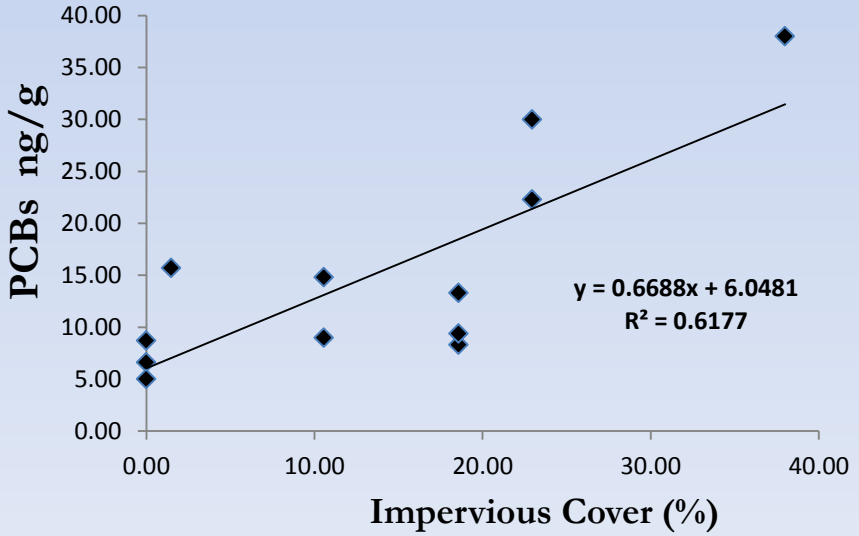


Moving Down the Ladder -- Fishes



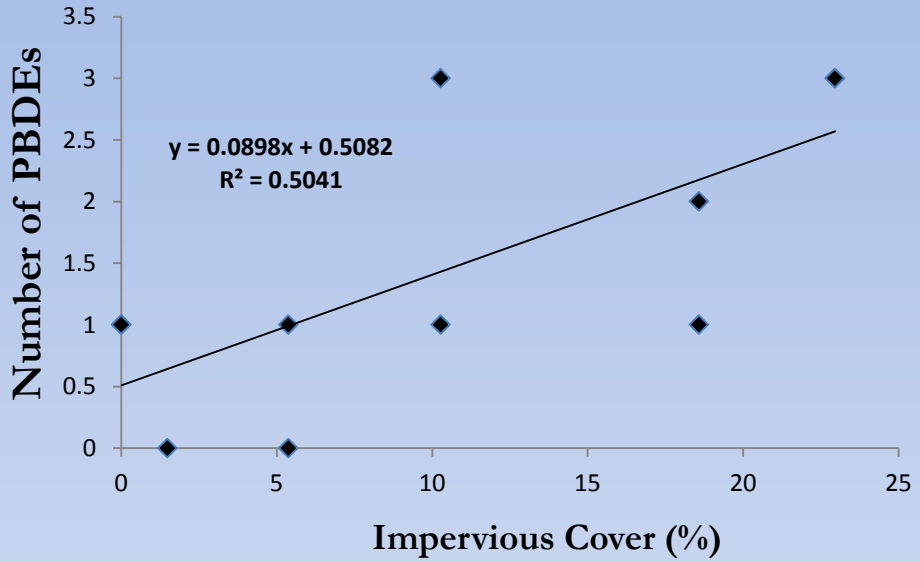


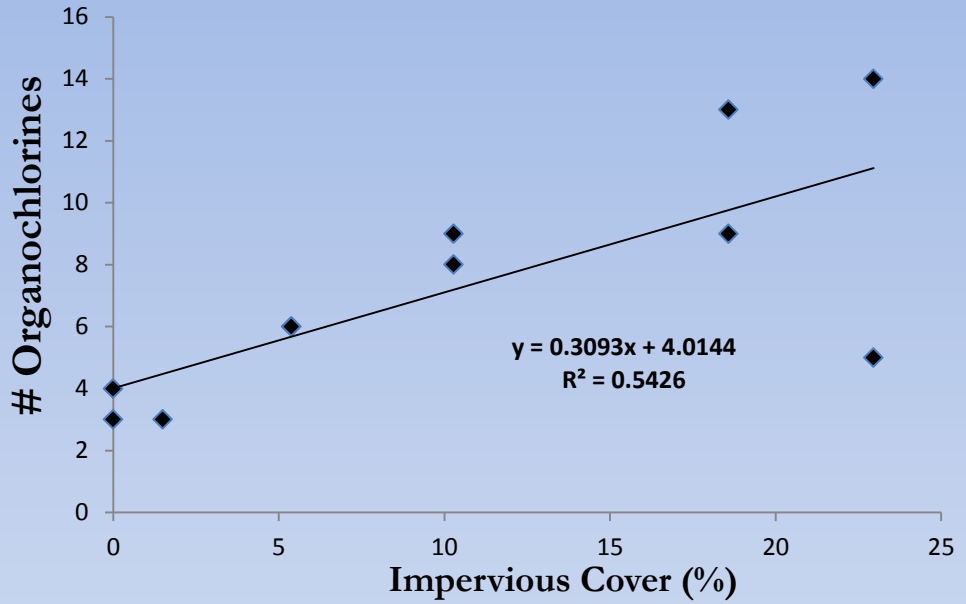


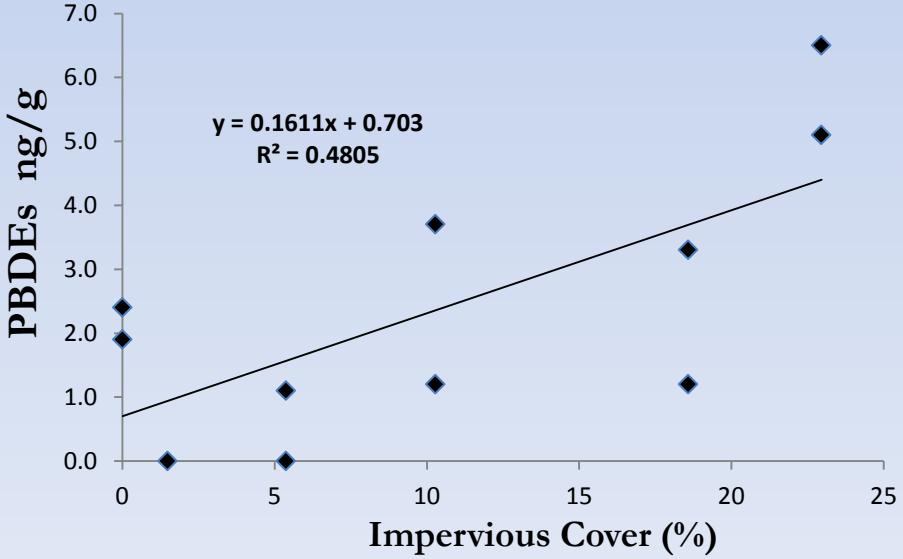


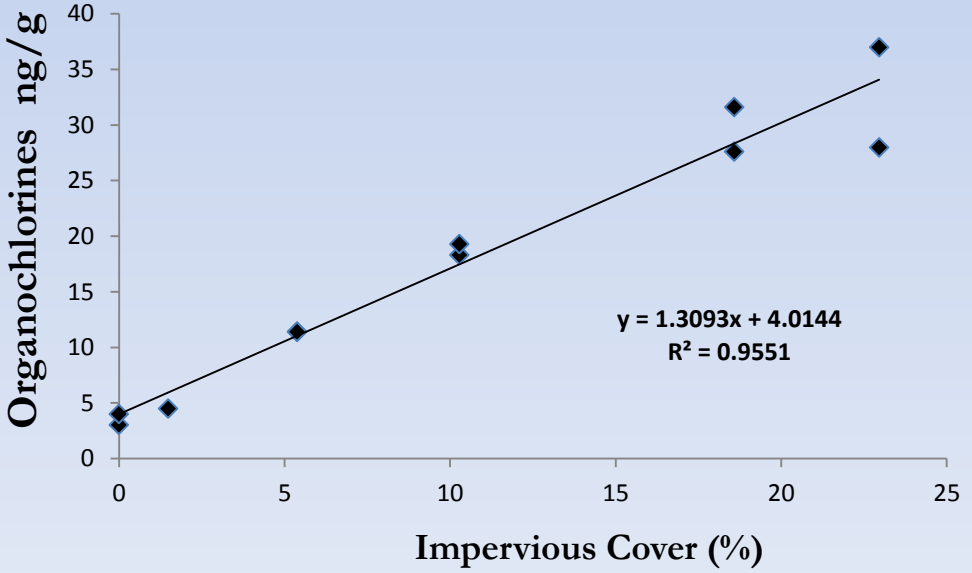
Salamander Tissue Analysis

Salamander tissue from 11 composite samples



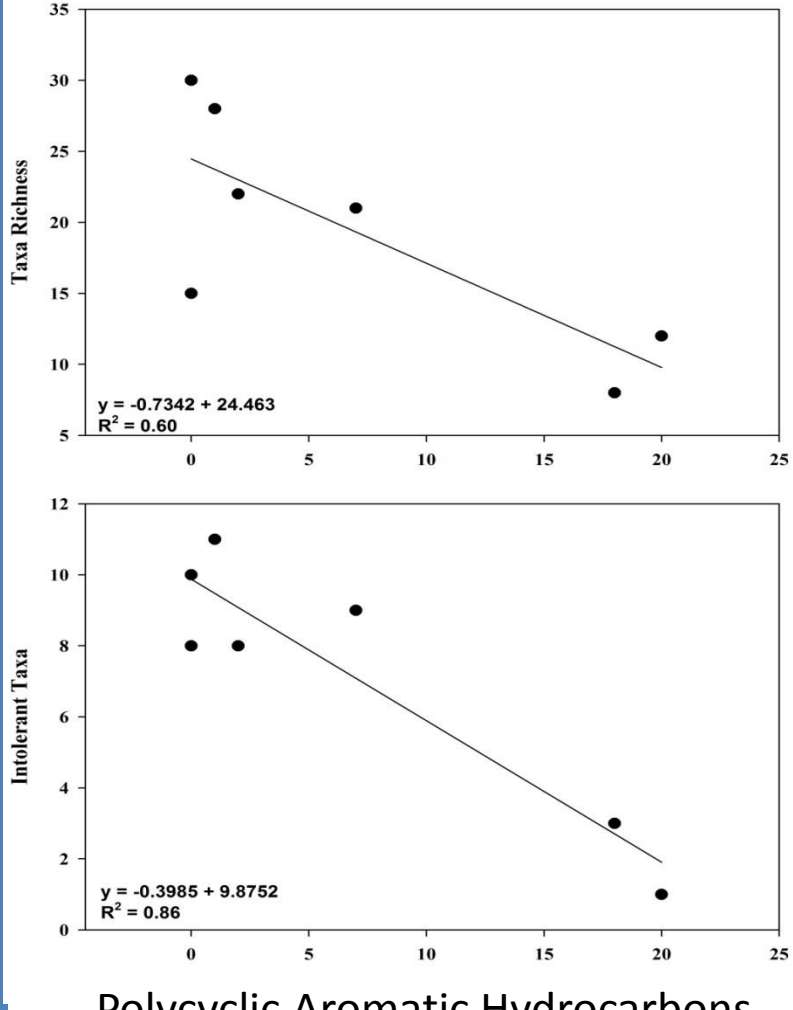






Aquatic Invertebrates and SPMDs

SPMD	r	TestStat	N	p
Ephemeroptera Taxa	-0.84	-3.60	7	0.01
Percent Dominant Taxa	0.85	3.71	7	0.01
Intolerant Taxa	-0.90	-4.72	7	0.005
Percent Chironomidae	0.79	2.96	7	0.03
PAH	**r**	**TestStat**	**N**	**p**
Taxa Richness	-0.77	-2.76	7	0.03
Ephemeroptera Taxa	-0.88	-4.32	7	0.008
Percent Dominant Taxa	0.91	5.22	7	0.003
Intolerant Taxa	-0.92	-5.54	7	0.002
Percent Chironomidae	0.82	3.32	7	0.02
Aquatic Life Use Score	-0.77	-2.71	7	0.04



Polycyclic Aromatic Hydrocarbons

So What

- See strong relationship between impervious cover (urbanization) and contaminants in Central Texas (¿Surprise?)
- What methods do we use to track, measure, and identify the status of aquatic habitats in Texas as changes in land use occur
- Question: What about areas with stressors that are not urbanization
  - Trans Pecos Region

UII Multi-metric Model

- Population Density
- Infrastructure
- Land Use Data
- Water Quality
  - Aquatic Invertebrate Community
- Uses
  - Create threat based ranking system
  - Identify sites that have endemic species and create land management plans
  - Identify indicator species
  - Help shape restoration efforts

$$Y = 100\text{-}Y_{neg\ corr.}$$

$$URBI = \left(\sum_{1}^{n} Y_i \right) / n$$

$$X_{adj} = (X - X_{min}) \div (X_{max} - X_{min}) * 100$$

Data Collection

- USDA - HUC
- EPA – Ecoregion & TRI
- MRLC – Land Cover
- USACE – Dam Inventory
- Texas State Data Center – Roads & Census
- Aquatic Invertebrates

Model Creation for Central Texas

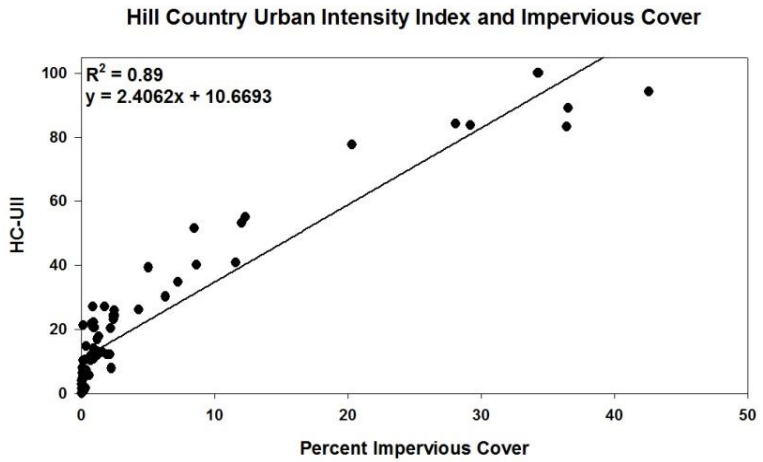
- 5-Step Process (McMahon and Cuffney 2000)
  - Adjust raw data (standardize)
  - Transform data (ranging from 0-100)
  - Flip negatively correlated values (100-Y)
  - Calculate URBI
  - Create range of URBI from 0-100 for UII
- Variables with correlation (±0.5) to population density used in HC-UII model
- No impervious cover used in model creation

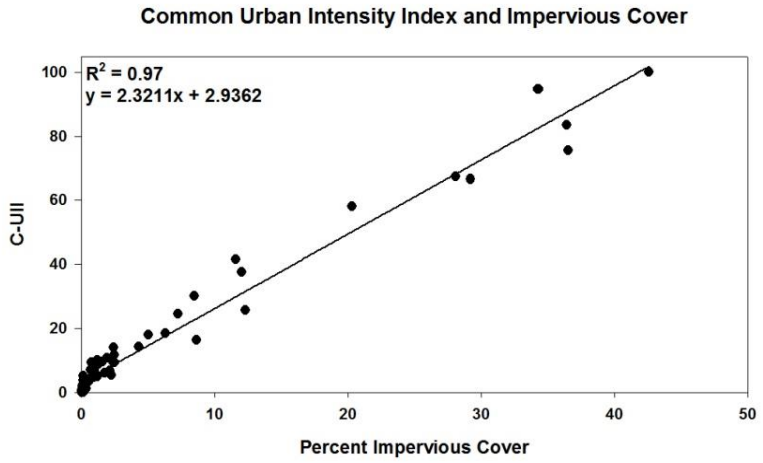
Hill Country UII

- Strong correlation with population density
  - percent developed land, TRI, percent forested land, road density, and housing density
  - Used to create HC-UII
  - Specific to the Central Texas region
- Common Urban Intensity Index
  - percent developed land, road density, and housing density (Cuffney and Falcone 2009)
  - For use on a large scale (state wide, nationwide)

UII relationships with Impervious Cover

- At 5% Imp CV
  - HC-UII – 22
  - C-UII – 14
- Pre-effect Zone (10%)
  - HC-UII – <34
  - C-UII – <26
- Effect Zone (+25%)
  - HC-UII – 34-70
  - C-UII – 26-60



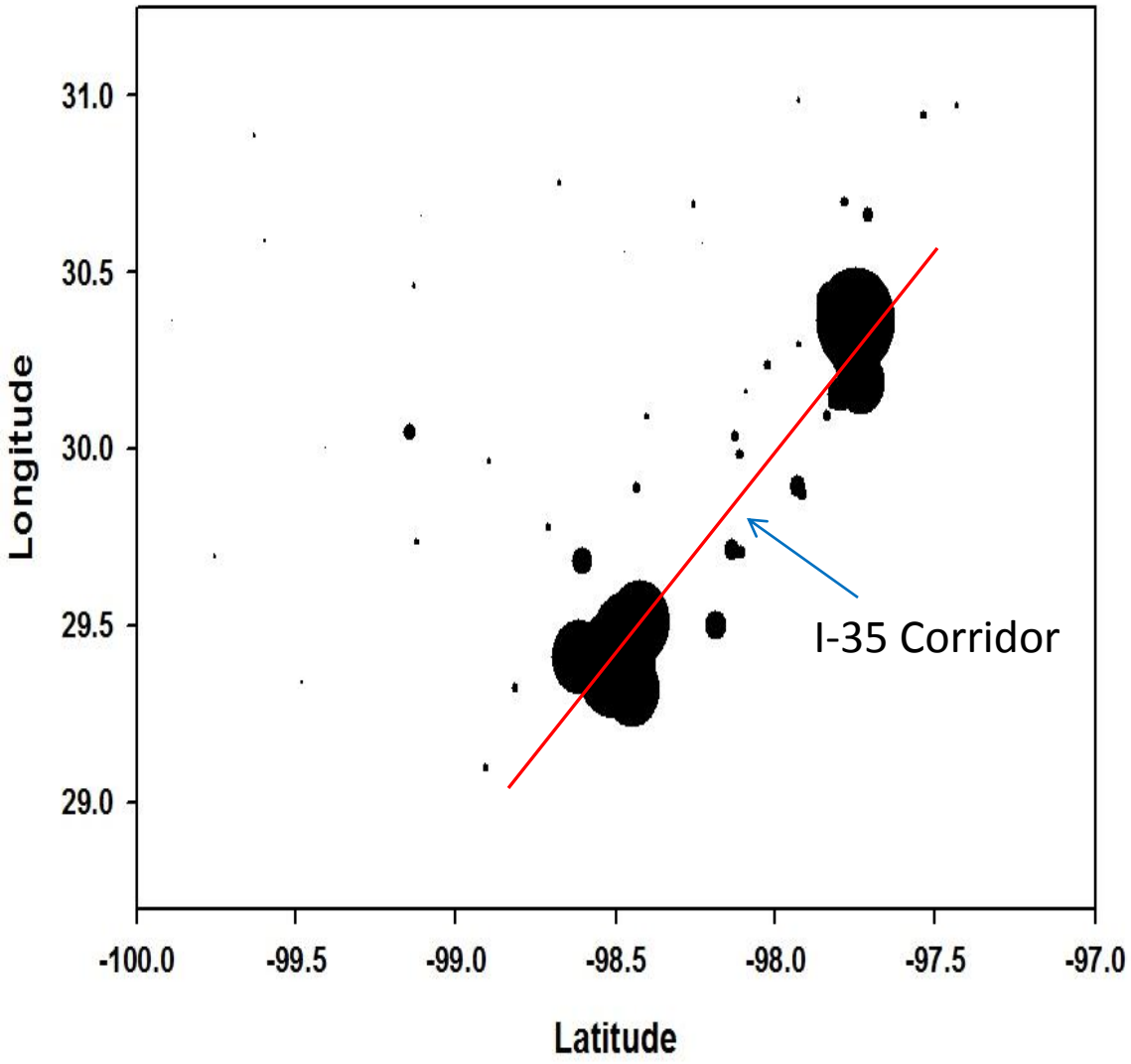


The Good the Bad and the Worse

- 45 sites below HC-UII of 22
- 4 sites in pre-effect zone
- 11 sites in effect zone
- Frio and Llano (Edwards and Real)
- Salado Creek and Onion (Bell and Travis)
- San Pedro Creek (Bexar)



HC-UII Scores and Geographic Position



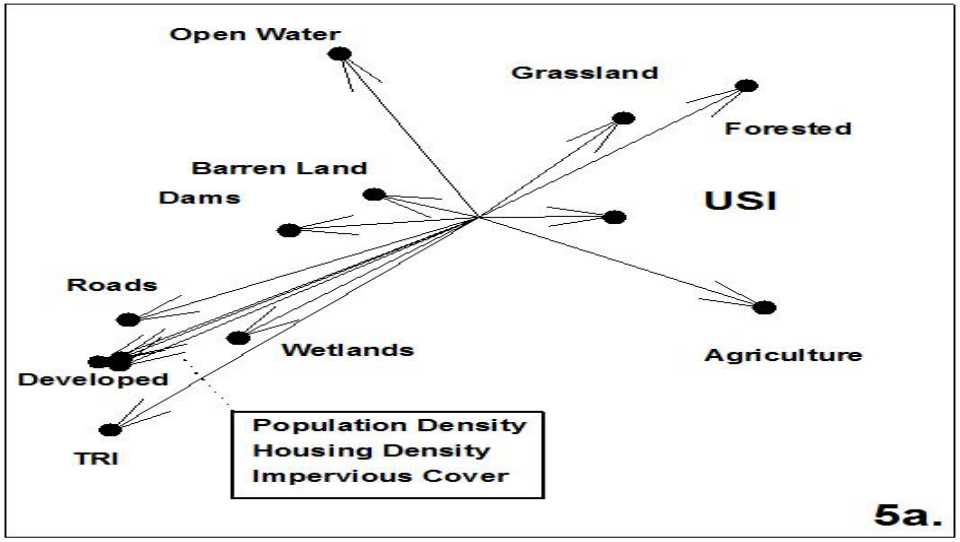
Adding Invertebrates

- 41,578 aquatic inverts identified from 55 sites in 21 Counties
- Use inverts to examine relationship with HC-UII and C-UII in Texas
- Examine changes community structure associated with urbanization
- Determine metrics associated with urbanization

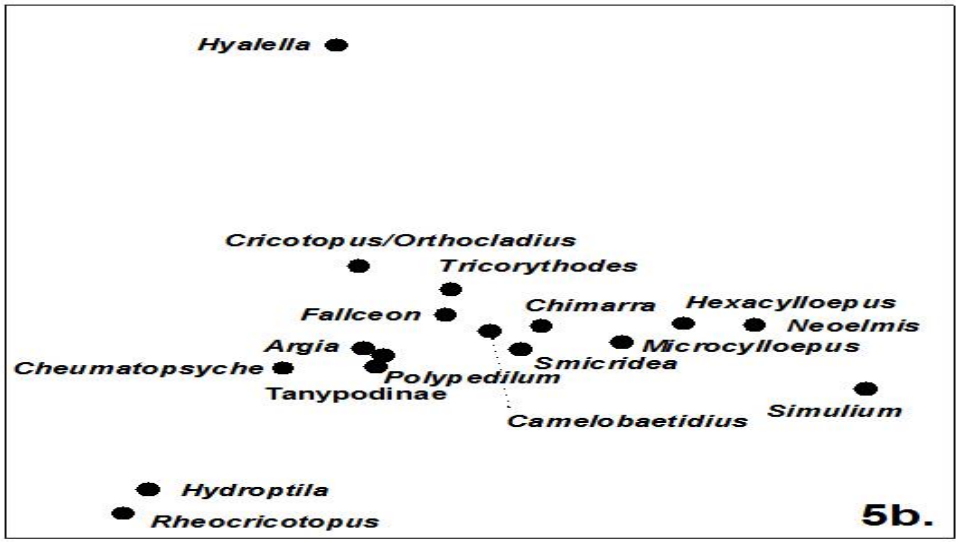
Aquatic Invertebrate Metrics

- A total of 15 different metrics
  - Tolerance Metrics
    - %Ephemeroptera, Intolerant/Tolerant, %Tolerant, # Intolerant, Diptera Taxa
  - Taxonomic Composition
    - HBI, % Dominant, Percent Chironomidae, % Hydropsyche
  - Taxonomic Richness
    - Ephemeroptera Taxa, Total Taxa, EPT
  - Functional Feeding Group
    - % Grazers, % Filterers, % Gatherers

41% of Variance explained by CCA

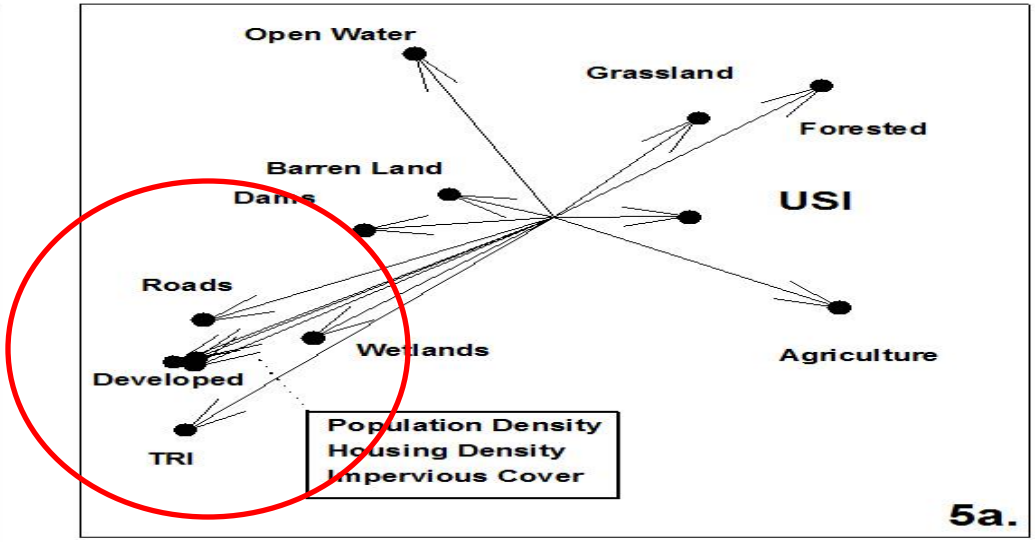


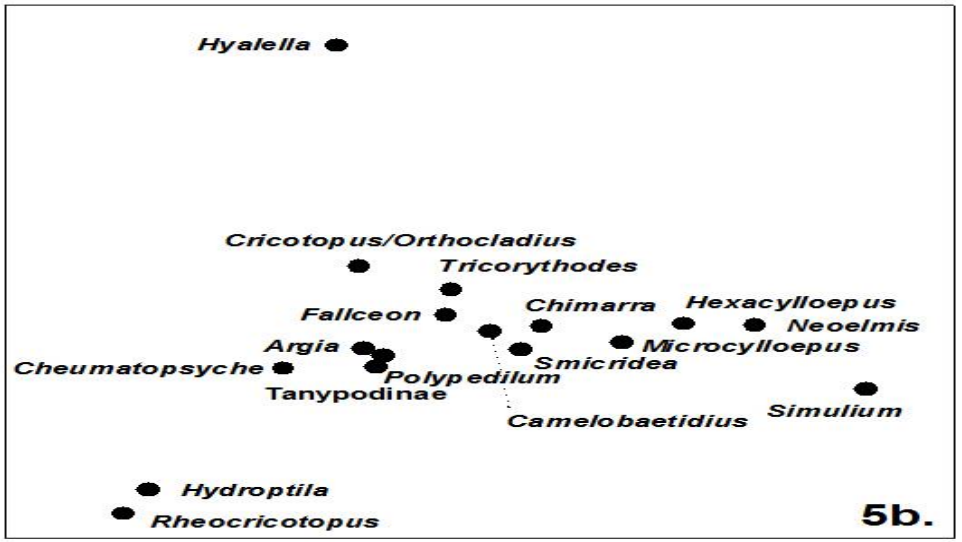
CA II



CA I

41% of Variance explained by CCA

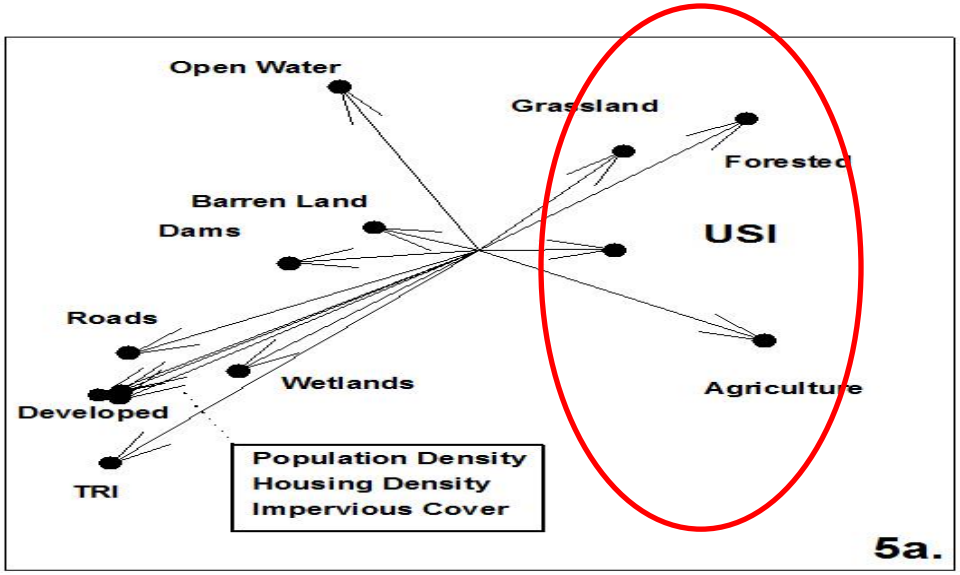


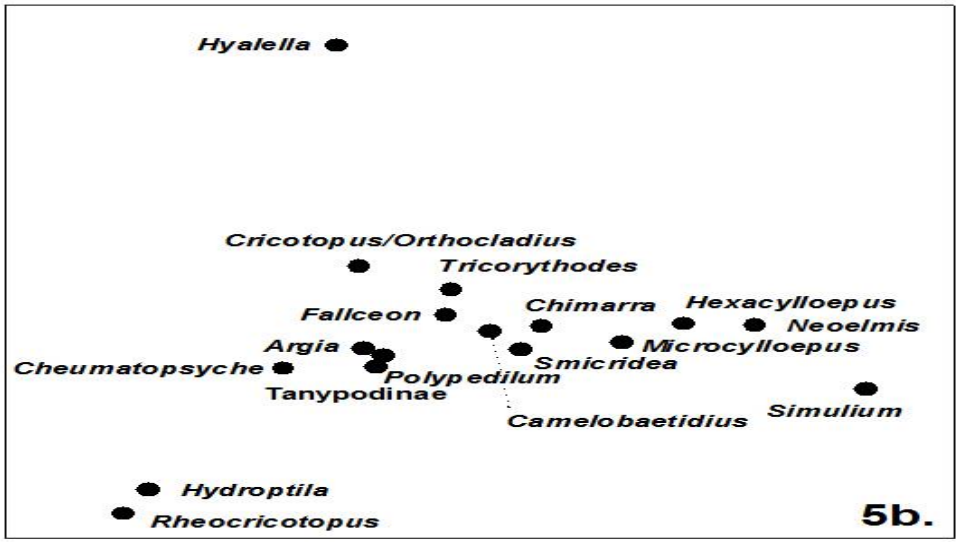


CA II

CA I

41% of Variance explained by CCA

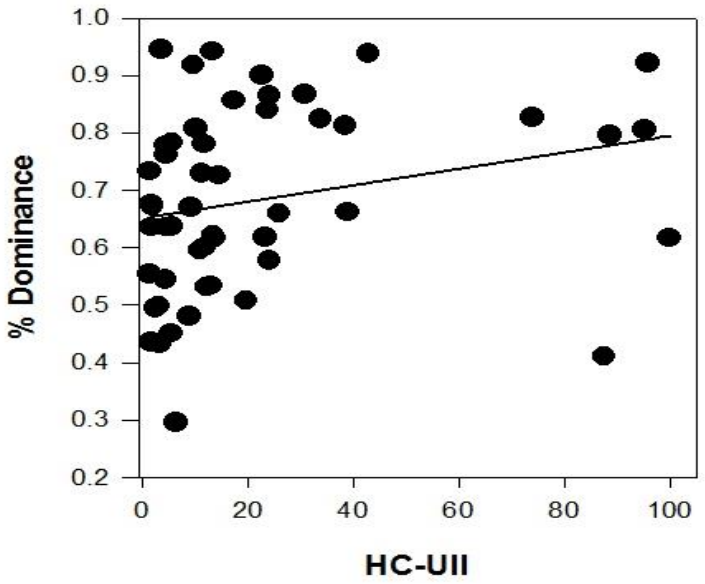


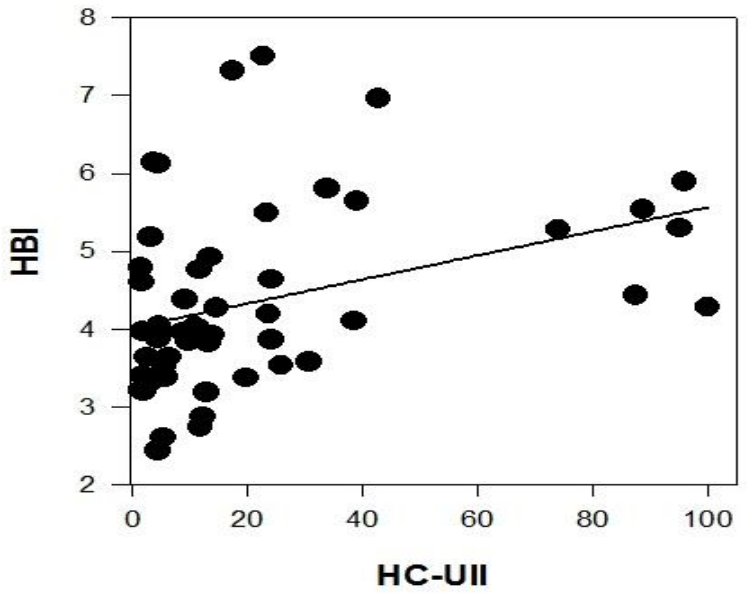


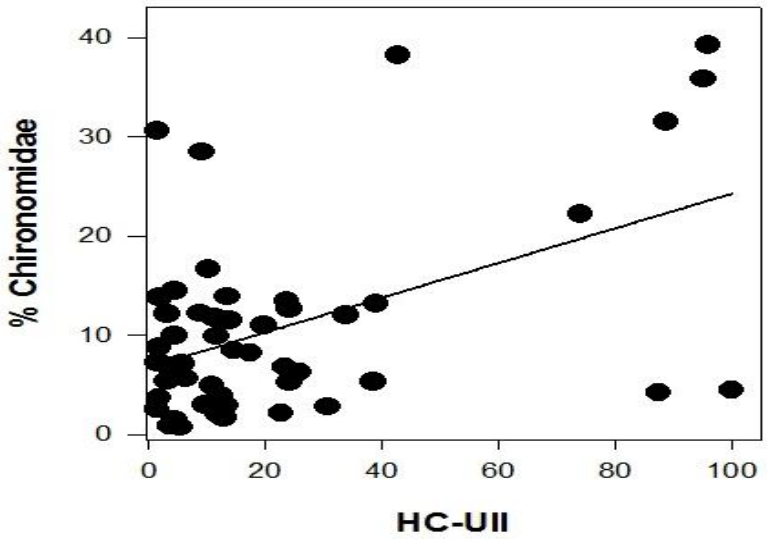
CA II

CA I

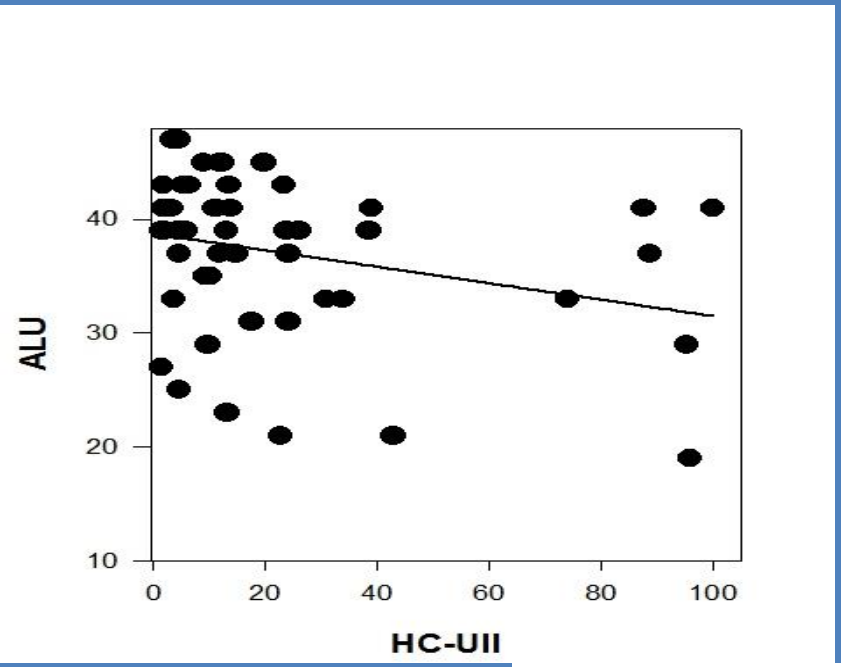
Univariate Analysis

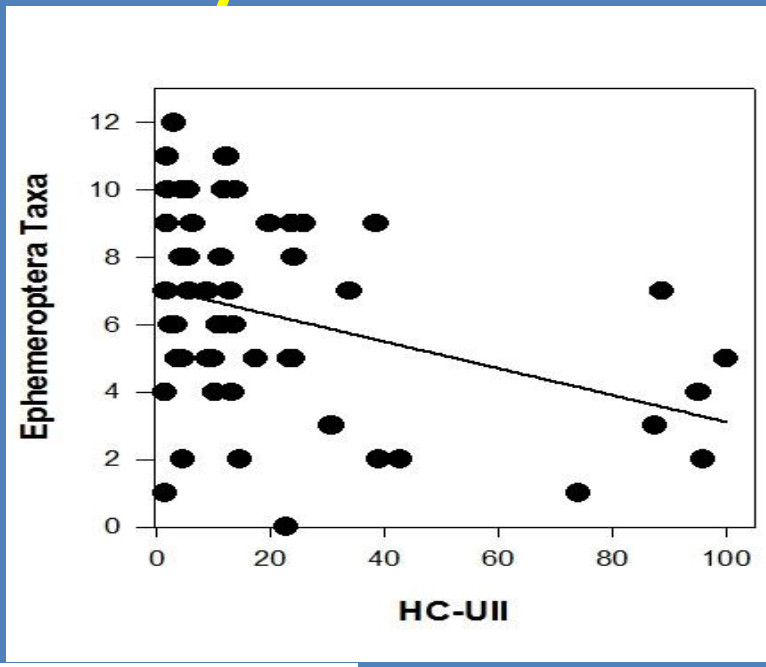


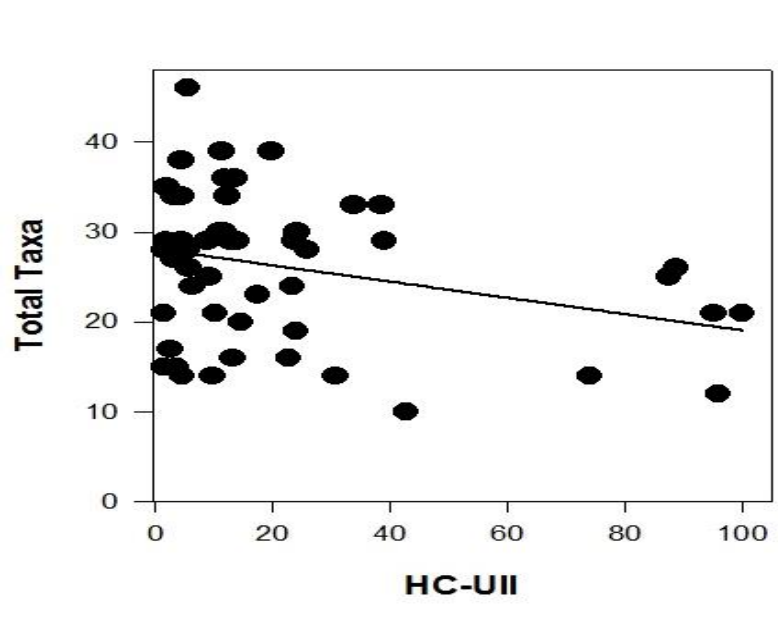




Univariate Analysis







Aquatic Invertebrate Data

- 55 sites used for analysis
  - 0 limited
  - 5 intermediate
  - 16 High
  - 34 Exceptional
- Metrics significantly correlated with UII's:
  - HBI
  - Percent Dominant
  - Ephemeroptera
  - Tolerance Ratio
- Metrics significantly correlated with impervious cover:
  - HBI
  - Percent Dominant
  - Ephemeroptera
  - Tolerance Ratio
  - Total Taxa
  - Intolerant Taxa

Comparison to Literature

Model0	Pre-Effect Zone	Effect Zone	High Effect Zone
HC-UII	<34	34-70	70+
MA-UII DFW	<39	39-68	69+
McMahon and Cuffney (2000) N-UII	<28	28-66	66+
C-UII	<26	26-60	60+

Cuffney and Falcone 2009 Data

	MAUII	MANUII	NUII
Impervious Cover	0.92	0.95	0.97

	HC-UII	C-UII
Impervious Cover	0.886	0.947

Summary

- Multi-Metric Indices aid in site selection and conservation land management practices
- When looking for thresholds of community structure use impervious cover
- Central Texas is still in early stages of development

Now What

- This area is unique to the world
- Gap in data
- A few sites been developed
- Critical time to implement policy, incentive programs to protect sensitive areas